REMARKS

In the above-identified Office Action, the Examiner has rejected claims 4, 5, and 22 as failing to comply with the written description requirement. Claim 8 has been rejected under the same grounds. Applicant has cancelled these claims and replaced them with new claim 44 which is considered to comply with the written description requirement.

Claims 8-9 have been rejected as unpatentable over Graef et al. and Tamatsuka et al. Claims 8, 9, and 42 have been rejected as unpatenable over Wijarankula in view of Graef et al or Tamatsuka et al. Claim 25 has been rejected over Wijarankula in view of Graef or Tamatsuka and further in view of Hakomori. As stated above applicant has cancelled all of the rejected claims and replaced them with claim 44 which it considers to be patentable over such references.

The nitrogen concentration in the silicon ingot is changed only by "the characteristic that the nitrogen concentration increases from the shoulder to the tail of the silicon ingot", that is, by the effect of segregation, and cannot be changed by the conditions for manufacturing the silicon ingot. Therefore, even though the oxygen concentration and the nitrogen concentration of the silicon ingot shoulder are within the condition range, there may be a case where the nitrogen concentration deviates from the condition range during the crystal growth process. In this case, the yield of the products is lowered.

The present invention is arranged to maintain the oxygen concentration and the nitrogen concentration within the recited concentration range by "controlling an oxygen concentration in accordance with a change in a nitrogen concentration based on a characteristic that the nitrogen concentration increases from a shoulder portion to a tail portion of a silicon ingot", that is, by controlling the oxygen concentration during the crystal growth process which taking the change in the nitrogen concentration by the above-mentioned characteristic into consideration.

According to the present invention, it is possible to make an epitaxial wafer substrate with less defects in all the portions from the shoulder to the tail of the silicon ingot. Tamatsuka does not disclose the recited element that the oxygen concentration is controlled in accordance with the change in the nitrogen concentration based in the characteristic that the nitrogen concentration increases and the oxygen concentration decreases from the shoulder to the tail of the silicon ingot.

Furthermore, because the present invention can use high-concentration oxygen, it is

possible to make the oxygen precipitation in the substrate in a high-concentration. On the other hand, because Tamatsuka uses low-concentration oxygen, there occurs the problem that precipitation nucleus melts in the high-temperature heating process performed in the process of providing a nest epitaxial layer if the precipitation nucleus density is low. To avoid this problem, it is necessary in Tamatsuka's invention to perform a middle temperature heating process to stabilize the precipitation nucleus. According to the present invention, because high-concentration oxygen (the recited range) can be used, the middle temperature heating process is not necessary.

Graef discloses neither the upper limit of the oxygen concentration and the nitrogen concentration not the technique for controlling based on the relationship between the oxygen concentration and the nitrogen concentration. Namely, Graef does not disclose the method step of "controlling an oxygen concentration in accordance with a change in the nitrogen concentration based on a characteristic that the nitrogen concentration increases from a shoulder portion to a tail portion of the silicon ingot". Even though an epitaxial layer is provided on the silicon wafer using the technique of Graef, defects are generated in many of the epitaxial layers and so an epitaxial layer with minimal defects cannot be obtained, unlike the present invention. This problem is caused whether the second heat treatment is performed or not.

The concept of both inventions is completely different. The object of Graef is to decrease the defect density. Graef decreases the defect density by a heat treatment exceeding an hour. On the other hand, the object of the present invention is to increase the defects in the silicon wafer in a manner that does not propagate into the epitaxial layer. The present invention does not control the defects by heat but controls by adjusting the oxygen concentration and the nitrogen concentration, so that the heat treatment performed in Graef is not required. In the meantime, in the present invention, the temperature for manufacturing the epitaxial layer is set to 1100°C, and in most cases, the growth time of the epitaxial layer is within one minute. Compared to the heat treatment exceeding one hour (like in Graef), this heat treatment completely differs in its effect on the defects.

Thus if Wijarankula were combined with either of Graef or Takasuka, the subject invention as now claimed would not find each of the elements claimed in such disclosures, and would not be obvious therefrom.

Applicant hereby requests reconsideration and reexamination thereof.

With the above amendments and remarks, this application is considered ready for allowance and Applicant earnestly solicits an early notice of same. Should the Examiner be of the opinion that a telephone conference would expedite prosecution of the subject application, he is respectfully requested to call the undersigned at the below-listed number.

Respectfully submitted,
WELSH & KATZ, LTD.

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Gerald T. Shekleton
Registration No. 27,466

WELSH & KATZ, LTD.
120 South Riverside Plaza
22nd Floor
Chicago, Illinois 60606-3912
Telephone: (312) 655-1500
Facsimile (312) 655-1501